VERIFICATION OF TRANSLATION

I, Tae-Ho Ha of 4th Floor, Susan Bldg., 824-9, Yeoksam-dong, Gangnam-gu, Seoul, 135-080, Republic of Korea, declare that I have a thorough knowledge of the Korean and English languages, and the writings contained in the following pages are correct English translation of the specification and claims of Korean Patent Application No. 2002-0039609.

This 8th day of June, 2005

By:

[Tae-Ho Ha]

KOREAN INTELLECTUAL

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[TITLE OF INVENTION IN ENGLISH] LCD with CLC color filter and CLC polariser

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[PURPORT] We submit application as above under the article 42 of the Patent Law.

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[FEES]

[BASIC APPLICATION FEE]	20 pages	29,000	Won
[ADDITIONAL APPLICATION FEE]	13 pages	13,000	Won
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[ENCLOSED] 1. Abstract, Specifications (with Drawings) – 1 set

[DOCUMENT OF ABSTRACT]

[ABSTRACT]

The present invention relates to a liquid crystal display device, more particularly, to a transmissive liquid crystal display device including a cholesteric liquid crystal color filter (CLC color filter).

The present invention suggests a transmissive liquid crystal display device having a first composition including a first polarizing plate having a right-handed pitch and a second polarizing plate having a left-handed pitch between a liquid crystal panel and a backlight, a second composition further including a diffusing plate inside a liquid crystal panel in the first composition, a third composition further including a compensation film over a diffusing plate in the second composition, and a fourth composition further including a retardation compensation film, which is over the liquid crystal panel in the first composition, inside a liquid crystal panel, another linear polarizing plate over a retardation compensation film and a diffusing plate between the liquid crystal panel and the linear polarizing plate.

Since a transmissive liquid crystal display device having the first, second, third and fourth compositions has a high brightness and a wide viewing angle, a transmissive liquid crystal display device of high quality can be fabricated.

[REPRESENTATIVE FIGURE]

FIG. 4

[SPECIFICATIONS]

[NAME OF INVENTION]

LCD with CLC color filter and CLC polariser

[BRIEF EXPLANATION OF FIGURES]

FIG. 1 is a schematic view of a conventional liquid crystal display device,

FIG. 2 is a schematic cross-sectional view of a conventional liquid crystal display device including a cholesteric liquid crystal color filter,

FIG. 3 is a view illustrating polarization characteristics of light passing through a liquid crystal display device of FIG. 2,

FIG. 4 is a schematic cross-sectional view of a transmissive liquid crystal display device according to a first embodiment of the present invention,

FIG. 5 is a view illustrating spectrum characteristics of the first and second cholesteric liquid polarizing plates and the backlight,

FIG. 6 is a view illustrating polarization characteristics of light passing through the liquid crystal display device of FIG. 4,

FIG. 7 is a schematic cross-sectional view of a liquid crystal display device according to a second embodiment of the present invention,

FIG. 8 is a schematic cross-sectional view of a liquid crystal display device according to a third embodiment of the present invention,

FIG. 9 is a schematic cross-sectional view of a liquid crystal display device according to a fourth embodiment of the present invention, and

FIG. 10 is a view illustrating polarization characteristics of light passing through a liquid crystal display device of FIG. 9.

< Explanation of major parts in the figures >

102 : upper substrate	104 : lower substrate
106 : CLC color filter	108 : liquid crystal layer
110 : retardation film	112 : linear polarizing plate
114 : first CLC polarizing plate	116 : second CLC polarizing plate

[DETAILED DESCRIPTION OF INVENTION]

[OBJECT OF INVENTION]

[TECHNICAL FIELD OF THE INVENTION AND PRIOR ART OF THE FIELD]

The present invention relates to a liquid crystal display device, and more particularly to a transmissive color liquid crystal display device including a cholesteric liquid crystal color filter (hereinafter, referred to as "a CLC color filter") and a cholesteric liquid crystal polarizing plate (hereinafter, referred to as "a CLC polarizing plate").

In general, a liquid crystal display (LCD) device makes use of optical anisotropy and polarization characteristics of liquid crystal molecules. The liquid crystal molecules have a definite orientational alignment that results from their thin and long shape. The alignment direction of the liquid crystal molecules can be controlled artificially by application of an electric field to the liquid crystal molecules.

Accordingly, if an intensity of the applied electric field changes so that the alignment of the liquid crystal molecules also changes, polarizing characteristics of an incident light

passing through a liquid crystal material is varied, and thus an intensity of the incident light passing through a polarizing plate is controlled and images can be displayed.

Presently, since active matrix LCD (AM-LCD) devices, where thin film transistors (TFTs) and pixel electrodes connected to the TFTs are disposed in a matrix form, have attracted attention supremely because of their high resolution and superior display of moving images.

A liquid crystal structure, which constructs a liquid crystal display device, is generally as follows.

FIG. 1 is a schematic view of a conventional liquid crystal display device.

As shown, the liquid crystal display (LCD) device 11 includes an upper substrate 5, where a color filter 7 including a black matrix 6 and sub color filters 8 (including red, green and blue sub color filters) and a transparent common electrode 18 on the color filter are formed, and a lower substrate 22, where a pixel region "P", a pixel electrode 17 on a pixel region "P" and array lines including a switching element "T" are formed, and a liquid crystal 14 is interposed between the upper substrate 5 and the lower substrate 22.

The lower substrate 22 is referred to as an array substrate. The thin film transistors "T" as switching elements are disposed in a matrix form. A gate line 13 and a data line 15 cross each other at a portion where the plurality of thin film transistors "T" are disposed.

The pixel region "P" is defined by a cross of the gate line 13 and the data line 15. The pixel electrode 17 at the pixel region "P" is made of a transparent conductive material such as indium-tin-oxide (ITO) having high transmittance.

A backlight 30 is disposed under the LCD device 11 to supply light to the LCD device.

Operation of the active matrix LCD device is explained. When a signal is applied to the switching thin film transistor "T," a data signal is applied to the pixel electrode 17. When

a signal is not applied to the switching thin film transistor, a data signal is not applied to the pixel electrode 17.

That is, the LCD device is a kind of light modulating device which switches light.

In general, the LCD device 11 uses light emitted from the backlight 30. In order that the light from the backlight 30 passes through the color filter 8 to display images, it passes through a plurality of functional thin films, and thus the LCD device is a light modulating device having a very poor efficiency.

The functional thin films include two linear polarizing plates (not shown) modulating a polarization state of the light from the backlight, the color filter 8 coloring the light from the backlight and so on.

However, the linear polarizing plates (not shown) transmit only linear component of the light from the backlight 30 i.e., linearly polarized light along a specific direction, and since those transmit a portion less than about half of light emitted from the backlight 30, the backlight 30 is not effectively used. That is, a brightness of the LCD device is reduced.

Moreover, as the color filter 8 used for the LCD device is generally an absorption type color filter, it causes heavy losses of the light from the backlight 30 when the light passes the color filter.

To solve the problem of brightness reduction, the color filter should have high transmittance. To do this, color purity of the color filter should be reduced. However, there is a limitation to increase brightness only by reducing color purity.

To solve the brightness problem of LCD devices, LCD devices using a cholesteric liquid crystal color filter (Cholesteric LC ; CLC) and a cholesteric liquid crystal polarizing plate have been researched and developed.

Hereinafter, with reference to a transmissive color liquid crystal display device of FIG. 2, light transmittance characteristics of the cholesteric liquid crystal color filter and the cholesteric liquid crystal polarizing plate are explained.

FIG. 2 is a schematic cross-sectional view of a transmissive liquid crystal display device including a cholesteric liquid crystal color filter and a cholesteric liquid crystal polarizing plate.

As shown, a conventional transmissive liquid crystal display (LCD) device 50 including a CLC color filter and a CLC polarizing plate includes a first substrate 52, a CLC color filter 54, a liquid crystal layer 58 and a second substrate 58 over the first substrate 52, a retardation film (QWP: λ/4 plate) and a linear polarizing plate 62 over the second substrate 58.

A polarizing plate 64 and a backlight 66 is disposed under the first substrate 52.

In the above explained composition, in cholesteric liquid crystal used for the color filter 54 and the polarizing plate 64, alignment vectors of cholesteric liquid crystal molecules form a helical structure. The cholesteric liquid crystal molecules twisted with a right-handed helical direction reflect right-handed circularly polarized light, while the cholesteric liquid crystal molecules twisted with a left-handed helical direction reflect left-handed circularly polarized light. (That is, when a polarization state of incident light is equal to the helical direction and satisfies a Bragg's reflection condition, the incident light is reflected.)

In the above explained conventional composition, the CLC color filter 54 uses cholesteric liquid crystal with a left-handed helical direction and the polarizing plate 64 uses cholesteric liquid crystal with a right-handed helical direction.

In this case, a left-handed circularly polarized light among light of a broadband of wavelength passes through the CLC polarizing plate 64. The left-handed circularly polarized light passes through the CLC color filter 54 and reaches the liquid crystal layer 56.

At this point, the CLC color filters 54 transmit red, green and blue color lights such that respective pixels display red, green and blue colors. For example, in a pixel for red color, the cholesteric liquid crystal films having pitches corresponding to wavelengths of green and blue colors are formed.

In this case, left-handed circularly polarized light, among light having a broadband of wavelength, corresponding to green and blue colors is reflected and left-handed circularly polarized light corresponding to red color is transmitted and observed.

Such principle can be identically applied to pixels for green and blue colors.

Hereinafter, with reference to FIG. 3, polarization characteristics of light passing through the above explained transmissive LCD device are explained.

FIG. 3 is a view illustrating polarization characteristics of light passing through a liquid crystal display device of FIG. 2.

At first, light emitted from a backlight 66 has disorder characteristics and includes nearly all wavelength bands.

When the light meets the CLC polarizing plate 64, right-handed circularly polarized light reflects to the backlight 66 and only left-handed circularly polarized light passes through the CLC polarizing plate 64 according to characteristics of the CLC polarizing plate 64 (which is to reflect a right-handed circularly polarized light).

At this point, the right-handed circularly polarized light reflecting to the backlight 66 reflects from the backlight 66, and it is inverted to left-handed circularly polarized light, thereby passing through the CLC polarizing plate 64.

That is, most circularly polarized light has an inverted polarization direction during a recycling process of light and passes through the CLC polarizing plate 64.

When the light having a broadband of wavelength passing through the CLC polarizing plate 64 meets a CLC color filter 54, left-handed circularly polarized light having a specific peak wavelength among wavelengths of red, green and blue colors is transmitted. (That is because, in a red color pixel, the cholesteric liquid crystal reflecting left-handed circularly polarized lights of green and blue colors is stacked and thus it is possible to transmit left-handed circularly polarized light of red color.)

According to the above explained structure of the CLC color filter 54, in the pixel displaying red color, left-handed circularly polarized light having a peak wavelength of red color may be transmitted.

At this point, when the light reflecting from the CLC color filter 54 reflects from the CLC polarizing plate 64, it is inverted to left-handed circularly polarized light and passes through the CLC color filter 54. By repetition of the aforementioned process, most light corresponding to a main peak wavelength passes through the CLC color filter 54 without loss.

While the circularly polarized light that passing through the CLC color filter 54 passes through a liquid crystal layer 56 and a retardation film 60, it is retarded and changed into a linearly polarized light parallel to an optical axis of the linear polarizing plate 62, and then it is emitted to the outside.

As explained above, since cholesteric liquid crystal has a property of recycling light, it increases transmittance in comparison with a conventional linear polarizing plate and an absorption type color filter and thus high brightness can be obtained.

[TECHNICAL SUBJECT OF INVENTION]

However, since reflected light for an obliquely incident light has a shorter wavelength than that for a incident light to a front direction, phenomenon is occurred that light obliquely emitted has different red, green and blue colors from light emitted to a front direction.

That is, a color inversion is occurred and thus there is a problem that a viewing angle is narrow.

As the present invention is suggested to solve the above explained problems, a first cholesteric liquid crystal polarizing plate controlled to reflect a right-handed or left-handed circularly polarized light of a specific wavelength band and a second cholesteric liquid crystal polarizing plate controlled to reflect a right-handed or left-handed circularly polarized light of a broadband of wavelength are formed between a liquid crystal panel and a backlight.

In such case, light is collected toward a front direction

On the contrary, as deviated from a center of a liquid crystal panel, brightness decreases abruptly. To solve these problems, it is suggested that a compensation film over a diffusing plate is formed and a retardation film and a linear polarizing plate are formed.

Therefore, a color liquid crystal display device having a wide viewing angle and a high brightness can be fabricated.

[CONSTRUCTION AND OPERATION OF INVENTION]

To achieve the above explained object, a transmissive liquid crystal display device according to the present invention includes a linear polarizing plate; a retardation film under the linear polarizing plate; a first substrate under the retardation film; a liquid crystal layer under the first substrate; a CLC color filter under the liquid crystal layer; a second substrate under the CLC color filter; a first CLC polarizing plate under the second substrate and having a right-handed or left-handed pitch corresponding to a specific wavelength band; a second

CLC polarizing plate under the first CLC polarizing plate and having a pitch corresponding to a broadband of wavelength and opposite to the pitch of the first CLC polarizing plate; and a backlight under the second CLC polarizing plate.

In the above explained composition, a diffusing film between the liquid crystal layer and the retardation film and diffusing light, which is emitted toward a lower portion, toward an upper portion can be further included.

Moreover, a compensation film for viewing angle over the first linear polarizing plate and the retardation compensation film and compensating a retardation value of light passing through the retardation compensation film and thus increasing a viewing angle can be further included.

The CLC color filter has characteristics of transmitting light corresponding to peak wavelength bands of red, green and blue colors and having a pitch opposite to the pitch of the first CLC polarizing plate.

Light of the backlight has characteristics of being dominant at peak wavelength bands corresponding to red, green and blue colors.

The first CLC polarizing plate has characteristics of transmitting a right-handed or left-handed circularly polarized light of peak wavelength bands of red, green and blue colors among light emitted from the backlight, and the retardation film is a $\lambda/4$ film, wherein light passing through the $\lambda/4$ film is retarded by $\lambda/4$.

A transmissive liquid crystal display device according to another aspect of the present invention includes a first linear polarizing plate; a diffusing film under the linear polarizing film and diffusing light; a first substrate under the diffusing film; a liquid crystal layer under the first substrate; a second linear polarizing plate under the liquid crystal layer; a retardation compensation film under the second linear polarizing film; a CLC color filter under the

retardation compensation film; a second substrate under the CLC color filter; a first CLC polarizing plate under the second substrate and having a right-handed or left-handed pitch corresponding to a specific wavelength band; a second CLC polarizing plate under the first CLC polarizing plate and having a pitch corresponding to a broadband of wavelength and opposite to the pitch of the first CLC polarizing plate; and a backlight under the second CLC polarizing plate.

A compensation film for viewing angle between the diffusing plate and the first linear polarizng plate and compensating a retardation value of light passing through the retardation compensation film and thus increasing a viewing angle can be further included.

The CLC color filter has characteristics transmitting light corresponding to peak wavelength bands of red, green and blue colors and having a pitch opposite to the pitch of the first CLC polarizing plate.

Light of the backlight is dominant at peak wavelength bands corresponding to red, green and blue colors.

The first CLC polarizing plate has characteristics transmitting a right-handed or left-handed circularly polarized light of peak wavelength bands of red, green and blue colors among light emitted from the backlight.

Hereinafter, reference will now be made in detail to embodiments according to the present invention, examples of which are illustrated in the accompanying drawings.

-- First embodiment --

A first embodiment of the present invention has characteristics of using CLC polarizing plates having different characteristics between a liquid crystal panel having a CLC color filter and a backlight.

FIG. 4 is a schematic cross-sectional view of a transmissive liquid crystal display device according to a first embodiment of the present invention.

As shown, in a transmissive liquid crystal display (LCD) device 100 according to the first embodiment of the present invention, a CLC color filter 106 and a liquid crystal layer 108 are interposed the first and second substrates 102 and 104, and a retardation film (QWP) 110 and a linear polarizing plate (linear polarizer) 112 are sequentially formed over the first substrate 102.

First and second CLC polarizing plates 114 and 116 are formed under the second substrate 104.

A backlight 118 is disposed under the second CLC polarizing plate 116.

The backlight 118 has characteristics of a spectrum that light having peak wavelength bands corresponding to red, green and blue colors is dominant. The second CLC polarizing plate 116 has left-handed or right-handed helical pitch corresponding to a broadband of wavelength.

The first CLC polarizing plate 114 does not have a continuous pitch but a discrete pitch of left-handed helical pitch or right-handed helical pitch in a visible light range in order to collect the light of peak wavelengths corresponding to red, green and blue colors.

That is, the pitch of the first CLC polarizing plate 114 is adjusted to correspond not to all wavelengths in a visible light range but to a wavelength in a specific light range toward a thickness direction.

In the above explained composition, the first CLC polarizing plate 114 has a pitch opposite to the second CLC polarizing plate 116, and the CLC color filter 106 has a pitch opposite to the first CLC polarizing plate 114.

Hereinafter, with reference to FIG. 5, spectrum characteristics of the backlight, and the first and second CLC polarizing plates are explained.

FIG. 5 is a view illustrating spectrum characteristics of the first and second cholesteric liquid polarizing plates and the backlight.

As shown, a backlight 118 has spectrum characteristics that light having peak wavelength bands "λ_R," "λ_G" and "λ_B" corresponding to red, green and blue colors is dominant. That is, even though the light including almost all wavelengths is irradiated, the light of peak wavelength bands "λ_R," "λ_G" and "λ_B" corresponding to red, green and blue colors is dominant.

The second CLC polarizing plate 116 over the backlight 118 has a left-handed helical pitch of a broadband wavelength, and it reflects left-handed circularly polarized light among light of a broadband wavelength emitted from the backlight 118.

Accordingly, it reflects about 50% of light emitted from the backlight 118.

However, the reflected left-handed circularly polarized light also is inverted into right-handed circularly polarized light through a recycling process between the backlight 118 and the second CLC polarizing plate 116, thereby passing through the second CLC polarizing plate 116.

The first CLC polarizing plate 114 over the second CLC polarizing plate 116 has a right-handed helical pitch corresponding to wavelength bands except for peak wavelength bands of the red, green and blue colors.

That is, it reflects right-handed circularly polarized light corresponding to shorter wavelength bands shifting spectrum of the backlight 118 in a left direction.

Meanwhile, for light obliquely incident to the first CLC polarizing plate 114, right-handed circularly light 150 of a shorter wavelength is reflected, and it passes through the first

CLC polarizing plate 114 by the recycling process between the backlight 118 and the second CLC polarizing plate 116.

Accordingly, when the CLC polarizing plates having the above explained optical characteristics are used, the light irradiated from the backlight 118 and having wavelength bands corresponding to red, green and blue colors is collected toward a front direction. Therefore, high brightness is obtained in comparison with the conventional art.

At this point, the first and second CLC polarizing plates have not helical pitches of fixed direction but helical pitches of opposite direction.

Hereinafter, with reference to FIG. 6, optical characteristics of the LCD device including the first and second CLC polarizing plates are explained.

FIG. 6 is a view illustrating polarization characteristics of light passing through the liquid crystal display device of FIG. 4.

As shown, light of peak wavelength bands corresponding to red, green and blue colors emitted from a backlight 118 meets a second CLC polarizing plate 116 having left-handed helical pitch, and left-handed circularly polarized light is reflected and right-handed circularly polarized light is transmitted.

At this point, the reflected left-handed circularly polarized light is inverted into right-handed circularly polarized light through a recycling process between the backlight 118 and the second CLC polarizing plate 116, thereby passing through the second CLC polarizing plate 116.

Among the right-handed circularly polarized light passing the second CLC polarizing plate 116, right-handed circularly polarized light of peak wavelengths corresponding to red, green and blue colors passes through the first CLC polarizing plate 114.

At this point, the CLC plate has characteristics that it reflects obliquely incident light having a shorter wavelength. Accordingly, most of right-handed circularly polarized light passing through the backlight and the second CLC polarizing plate 116 is collected toward a front direction of the first CLC polarizing plate 114.

The light of peak wavelength bands of red, green and blue colors passing through the first CLC polarizing plate 114 is inverted into linearly polarized light having a polarization direction parallel to an optical axis of a linear polarizing plate 112 while passing through a CLC color filter 106, a liquid crystal layer 108 and a retardation film 110, thereby passing through the linear polarizing plate 112.

In the above explained composition, light of peak wavelength bands corresponding to red, green and blue colors is collected toward a front direction by the first CLC polarizing plate 114 reflecting only right-handed circularly polarized light of specific wavelength bands and the second CLC polarizing plate 116 reflecting left-handed circularly polarized among light of a broadband of wavelength. Accordingly, amount of light emitted toward a side region of the LCD panel is very little.

Therefore, differently from the conventional art, phenomenon is not occurred that a center region and a side region are displayed differently.

On the contrary, as deviated from a center of the LCD panel, brightness decreases abruptly. Hereinafter, second to fourth embodiments to solve these problems are explained.

-- Second embodiment --

A second embodiment of the present invention has characteristics of further including a diffusing plate (diffuser) into the liquid crystal display device of the first embodiment.

FIG. 7 is a schematic cross-sectional view of a transmissive liquid crystal display device according to a second embodiment of the present invention.

In a transmissive liquid crystal display (LCD) device 200 according to the second embodiment of the present invention, a CLC color filter 206 and a liquid crystal layer 208 are formed between first and second substrates 202 and 204, and a diffusing plate 210, a retardation film (QWP) 212 and a linear polarizing plate 214 are sequentially formed over the first substrate 202.

A first CLC polarizing plate 216 having right-handed helical pitch and a second CLC polarizing plate 218 having left-handed helical pitch are formed under the second substrate 204.

The first CLC polarizing plate 216 does not have a continuous pitch but a discrete right-handed helical pitch in a visible light range in order to collect the light of peak wavelengths corresponding to red, green and blue colors, and the second CLC polarizing plate 218 has a continuous pitch corresponding to a broadband of wavelength.

That is, the pitch of the first CLC polarizing plate is adjusted to correspond not to all wavelengths in a visible light range but to a wavelength in a specific light range toward a thickness direction. (The first CLC polarizing plate has a pitch opposite to the second CLC polarizing plate, and the CLC color filter has a pitch opposite to the second CLC polarizing plate.)

A backlight 220 is disposed under the second CLC polarizing plate 218.

The above explained composition can obtain a viewing angle in a liquid crystal panel of the first embodiment.

That is, since light collected toward a front direction of the liquid crystal layer 208 through the first and second CLC polarizing plates 216 and 218 is diffused through the diffusing plate 210, a wide viewing angle is obtained.

At this point, a hologram diffuser or a conventional diffuser in a backlight can be used as the diffusing plate 210.

Moreover, the diffusing plate 210 can be formed inside or outside the cell.

That is, it can be formed inside or outside the liquid crystal panel according to characteristics of display quality.

Hereinafter, a third embodiment suggests composition supplementing composition of the second embodiment.

-- Third embodiment --

A third embodiment further includes a compensation film for viewing angle over a diffusing plate into composition of the second embodiment.

FIG. 8 is a schematic cross-sectional view of a transmissive liquid crystal display device according to a third embodiment of the present invention.

As shown, in a transmissive liquid crystal display (LCD) device 300, a CLC color filter 306 and a liquid crystal layer 308 are formed between first and second substrates 302 and 304, and a diffusing plate 310, a retardation film (QWP) 312, a compensation film 314 for viewing angle and a first polarizing plate 316 are sequentially formed over the first substrate 302.

A first CLC polarizing plate 318 having right-handed helical pitch and a second CLC polarizing plate 320 having left-handed helical pitch are sequentially formed under the second substrate 304.

The first CLC polarizing plate 318 does not have a continuous pitch but a discrete right-handed helical pitch in a visible light range in order to collect the light of peak wavelengths corresponding to red, green and blue colors, and the second CLC polarizing plate 320 has a continuous pitch corresponding to a broadband of wavelength.

That is, the pitch of the first CLC polarizing plate 318 is adjusted to correspond not to all wavelengths in a visible light range but to a wavelength in a specific light range toward a thickness direction. (The first CLC polarizing plate has a pitch opposite to the second CLC polarizing plate, and the CLC color filter has a pitch opposite to the second CLC polarizing plate.)

A backlight 322 is disposed under the second CLC polarizing plate 320.

Through the above explained composition, when light emitted toward a front direction of the liquid crystal layer 308 through the first and second CLC polarizing plates 318 and 320 is diffused through the diffusing plate 310, the diffused light toward a side direction has a different retardation value from light toward a front direction while passing through the retardation film 312.

This causes reduction of contrast ratio in a side view.

To solve theses problems, the compensation film 314 for viewing angle is formed so that it compensates the retardation value difference through the retardation film 312.

Accordingly, a color difference between a front and a side can be compensated, and thus a viewing angle is wider.

Hereinafter, a fourth embodiment has characteristics of further including a compensation film and a separate polarizing plate between the liquid crystal layer and the first CLC polarizing plate.

-- Fourth embodiment --

FIG. 9 is a schematic cross-sectional view of a liquid crystal device according to a fourth embodiment of the present invention.

As shown, in a transmissive liquid crystal display (LCD) device 400, a CLC color filter 408, a retardation film (QWP) 410, a first linear polarizing plate 412 and a liquid crystal layer 416 are formed between first and second substrates 402 and 406.

A diffusing plate 418 and a second linear polarizing plate 420 are formed over the first substrate 402.

A first CLC polarizing plate 422 having right-handed helical pitch and a second CLC polarizing plate 424 having left-handed helical pitch are formed under the second substrate 406.

A backlight 426 is disposed under the second CLC polarizing plate 424.

In the above composition, when the compensation film 410 and the polarizing plate 412 are formed between the liquid crystal layer 416 and the CLC color filter 408, a retardation compensation film is not formed over the diffusing plate in comparison with the third embodiment. Accordingly, a viewing angle can be further obtained.

Hereinafter, with reference to FIG. 10, optical characteristics of a liquid crystal display device of FIG. 9 are explained.

FIG. 10 is a view illustrating optical characteristics of light passing through a liquid crystal display device of FIG. 9.

As shown, among scattered light emitted from a backlight 426, left-handed circularly polarized light reflects from a second CLC polarizing plate 424, to the contrary, other light including right-handed circularly polarized light passes through the second CLC polarizing plate 424.

At this point, the reflected left-handed circularly polarized light is inverted into right-handed circularly polarized light through a recycling process between the backlight 426 and the second CLC polarizing plate 424, thereby passing through the second CLC polarizing plate 424.

The right-handed circularly polarized light passing through the second CLC polarizing plate 424 passes through a first CLC polarizing plate 422 according to the above explained manner. Meanwhile, obliquely incident light of shorter wavelength among the right-handed circularly polarized light passing through the second CLC polarizing plate 424 reflects from the first CLC polarizing plate 422 and then is emitted toward a front direction of the first CLC polarizing plate 422 through the recycling process.

The right-handed circularly polarized light passing through the fist CLC polarizing plate 422 passes through a CLC color filter 408. Then, while it passing through a retardation film 410, it is inverted into a linearly polarized light having a polarization direction parallel to an optical axis of a first polarizing plate 412, thereby passing through the fist polarizing plate 412.

The light passing through the first linear polarizing plate 412 passes through a liquid crystal layer 416, a diffusing plate 418 and a second linear polarizing plate 420 and is emitted outside.

In the above explained composition, a compensation film for viewing angle may be further formed on the diffusing plate 418.

[EFFECT OF INVENTION]

Firstly, the transmissive liquid crystal display device according to the present invention includes a first CLC polarizing plate having helical pitch corresponding to peak

wavelength bands of red, green and blue colors and a second CLC polarizing plate. Accordingly, effect of superiorly collecting light can be obtained between a backlight and a liquid crystal panel.

Secondly, there is effect of fabricating a transmissive liquid crystal display device having high quality by reducing color differences between front and side positions.

[RANGE OF CLAIMS]

[CLAIM 1]

A liquid crystal display device, comprising:

a linear polarizing plate;

a retardation film under the linear polarizing plate;

a first substrate under the retardation film;

a liquid crystal layer under the first substrate;

a CLC color filter under the liquid crystal layer;

a second substrate under the CLC color filter;

a first CLC polarizing plate under the second substrate and having a right-handed or left-handed pitch corresponding to a specific wavelength band;

a second CLC polarizing plate under the first CLC polarizing plate and having a pitch corresponding to a broadband of wavelength and opposite to the pitch of the first CLC polarizing plate; and

a backlight under the second CLC polarizing plate.

[CLAIM 2]

The device according to claim 1, further comprising a diffusing film between the liquid crystal layer and the retardation film and diffusing light, which is emitted toward a lower portion, toward an upper portion.

[CLAIM 3]

The device according to claim 2, further comprising a compensation film for viewing angle over the first linear polarizing plate and the retardation compensation film and compensating a retardation value of light passing through the retardation compensation film and thus increasing a viewing angle.

[CLAIM 4]

The device according to claim 1, wherein the CLC color filter transmits light corresponding to peak wavelength bands of red, green and blue colors and has a pitch opposite to the pitch of the first CLC polarizing plate.

[CLAIM 5]

The device according to claim 1, wherein light of the backlight is dominant at peak wavelength bands corresponding to red, green and blue colors.

[CLAIM 6]

The device according to claim 5, wherein the first CLC polarizing plate transmits a right-handed or left-handed circularly polarized light of peak wavelength bands of red, green and blue colors among light emitted from the backlight.

[CLAIM 7]

The device according to claim 1, wherein the retardation film is a λ/4 film, wherein light passing through the λ/4 film is retarded by λ/4.

[CLAIM 8]

A liquid crystal display device, comprising:

a first linear polarizing plate;

a diffusing film under the linear polarizing film and diffusing light;

a first substrate under the diffusing film;

a liquid crystal layer under the first substrate;

a second linear polarizing plate under the liquid crystal layer;

a retardation compensation film under the second linear polarizing film;

a CLC color filter under the retardation compensation film;

a second substrate under the CLC color filter;

a first CLC polarizing plate under the second substrate and having a right-handed or left-handed pitch corresponding to a specific wavelength band;

a second CLC polarizing plate under the first CLC polarizing plate and having a pitch corresponding to a broadband of wavelength and opposite to the pitch of the first CLC polarizing plate; and

a backlight under the second CLC polarizing plate.

[CLAIM 9]

The device according to claim 8, further comprising a compensation film for viewing angle between the diffusing plate and the first linear polarizng plate and compensating a retardation value of light passing through the retardation compensation film and thus increasing a viewing angle.

[CLAIM 10]

The device according to claim 8, wherein the CLC color filter transmits light corresponding to peak wavelength bands of red, green and blue colors and has a pitch opposite to the pitch of the first CLC polarizing plate.

[CLAIM 11]

The device according to claim 8, wherein light of the backlight is dominant at peak wavelength bands corresponding to red, green and blue colors.

[CLAIM 12]

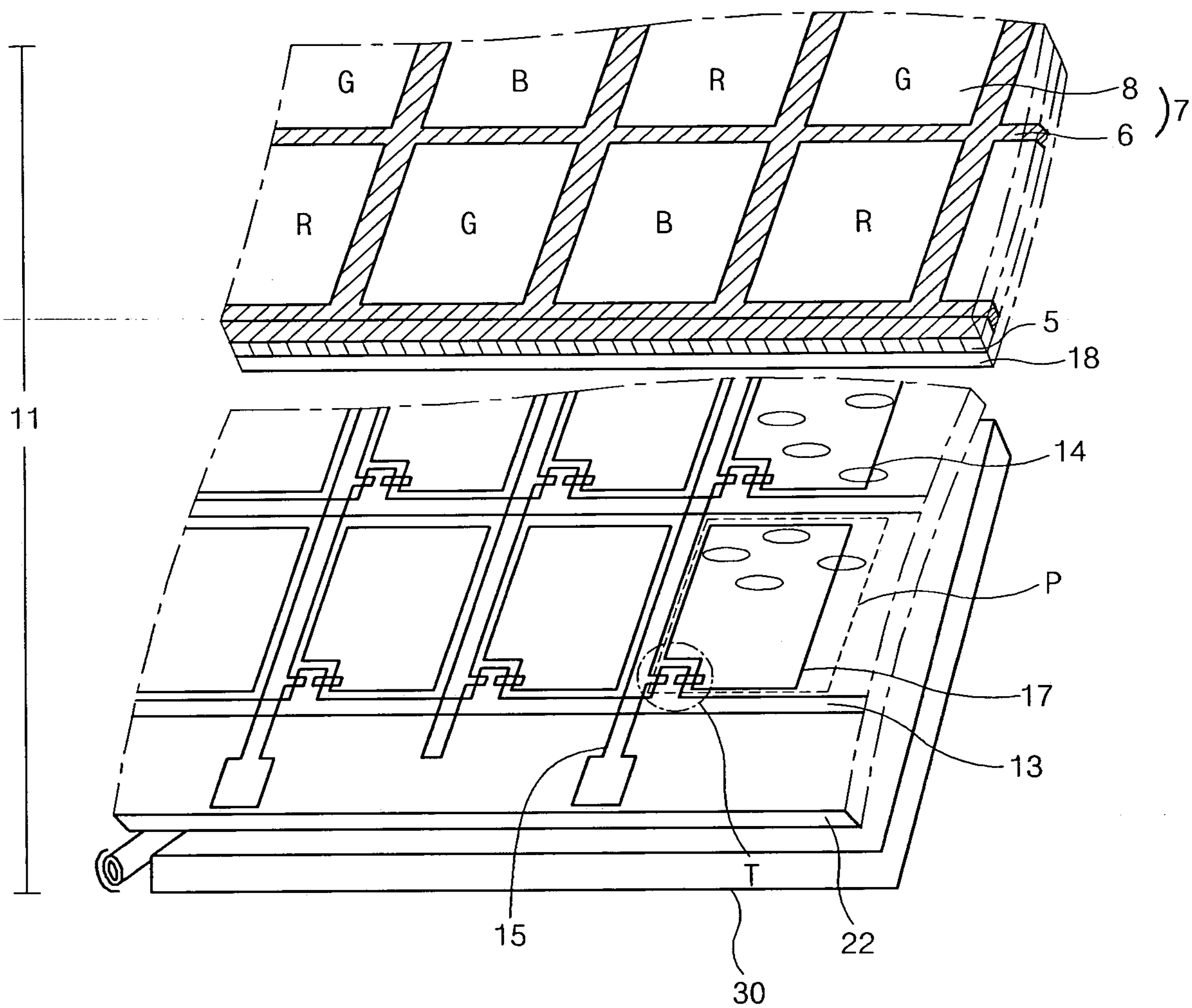
The device according to claim 11, wherein the first CLC polarizing plate transmits a right-handed or left-handed circularly polarized light of peak wavelength bands of red, green and blue colors among light emitted from the backlight.

[CLAIM 13]

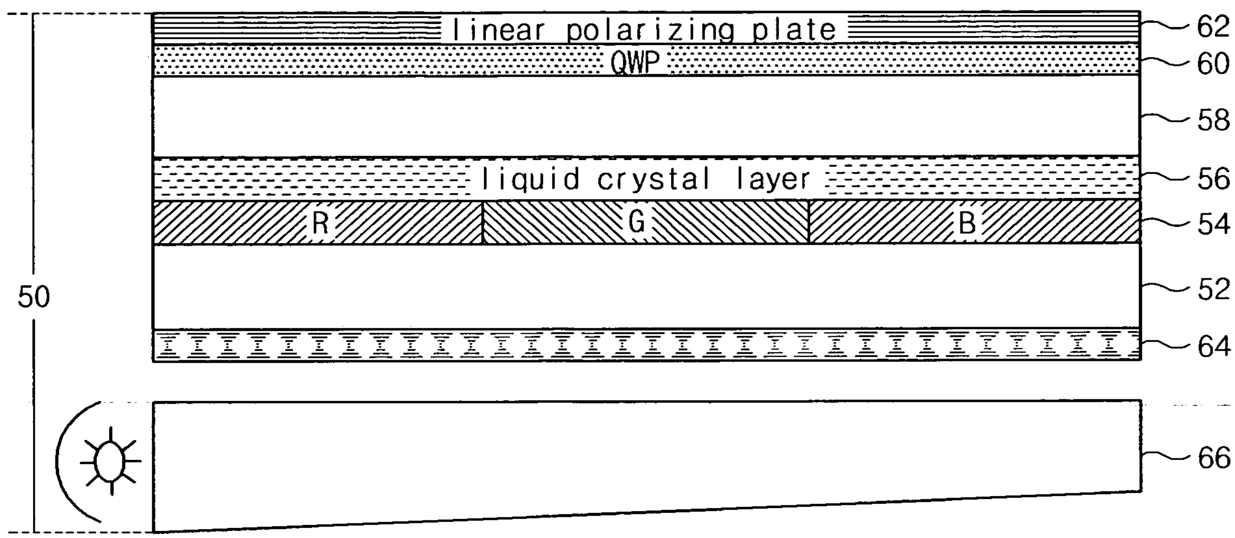
The device according to claim 8, wherein the retardation compensation film is a $\lambda/4$ film, wherein light passing through the $\lambda/4$ film is retarded by $\lambda/4$.

[DRAWINGS]

[FIG. 1]

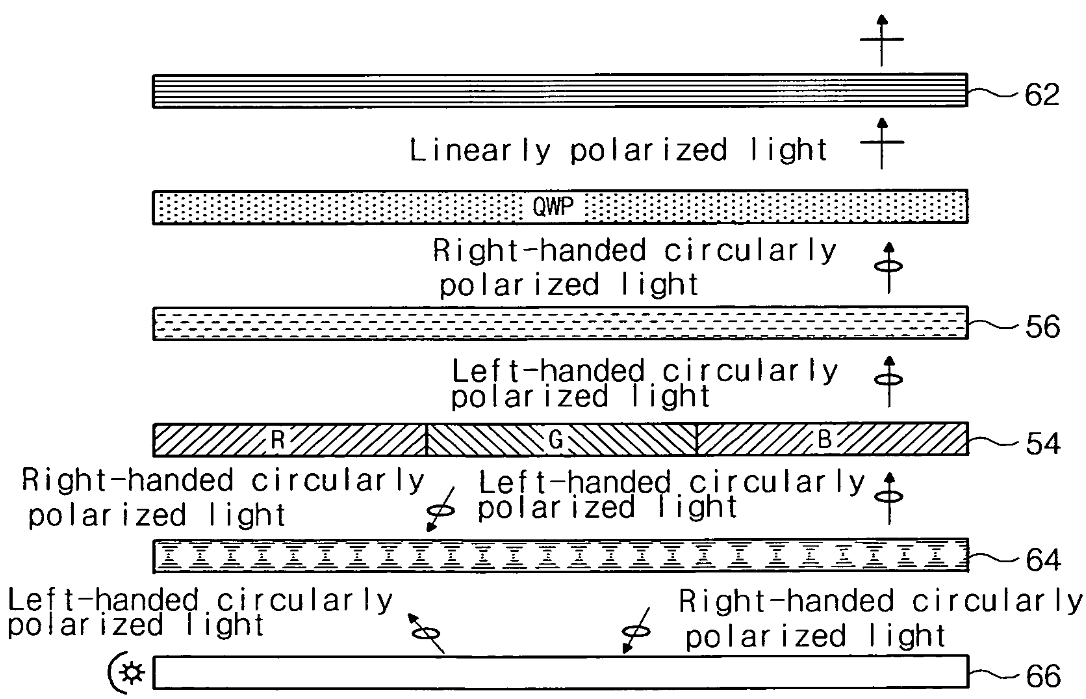


[FIG. 2]



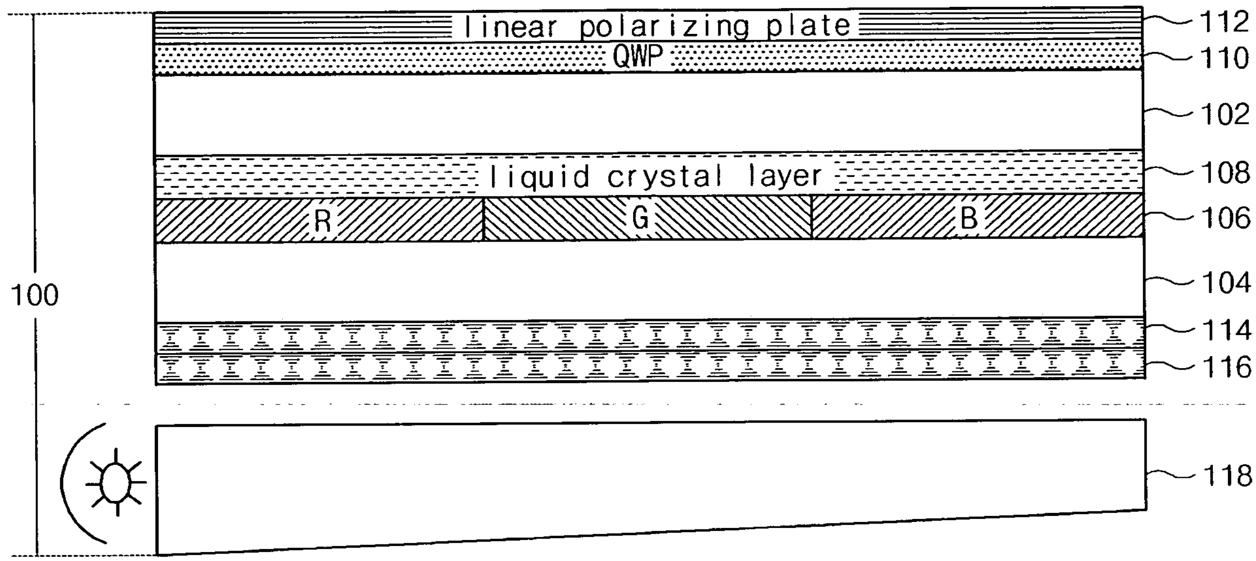
linear polarizing plate
QWP
liquid crystal layer
R
G
B
50
62
60
58
56
54
52
64
66

[FIG. 3]

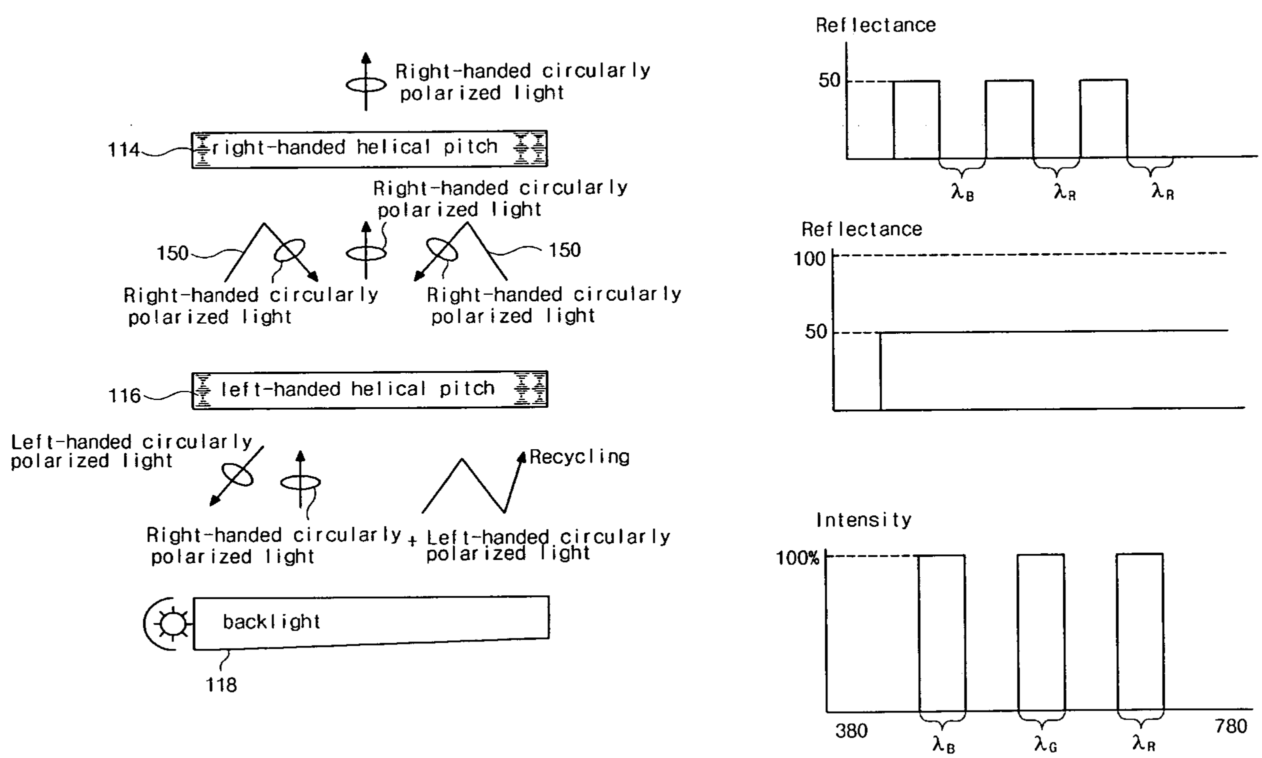


62
Linearly polarized light
QWP
Right-handed circularly polarized light
56
Left-handed circularly polarized light
R
G
B
54
Right-handed circularly polarized light
Left-handed circularly polarized light
64
Left-handed circularly polarized light
Right-handed circularly polarized light
66

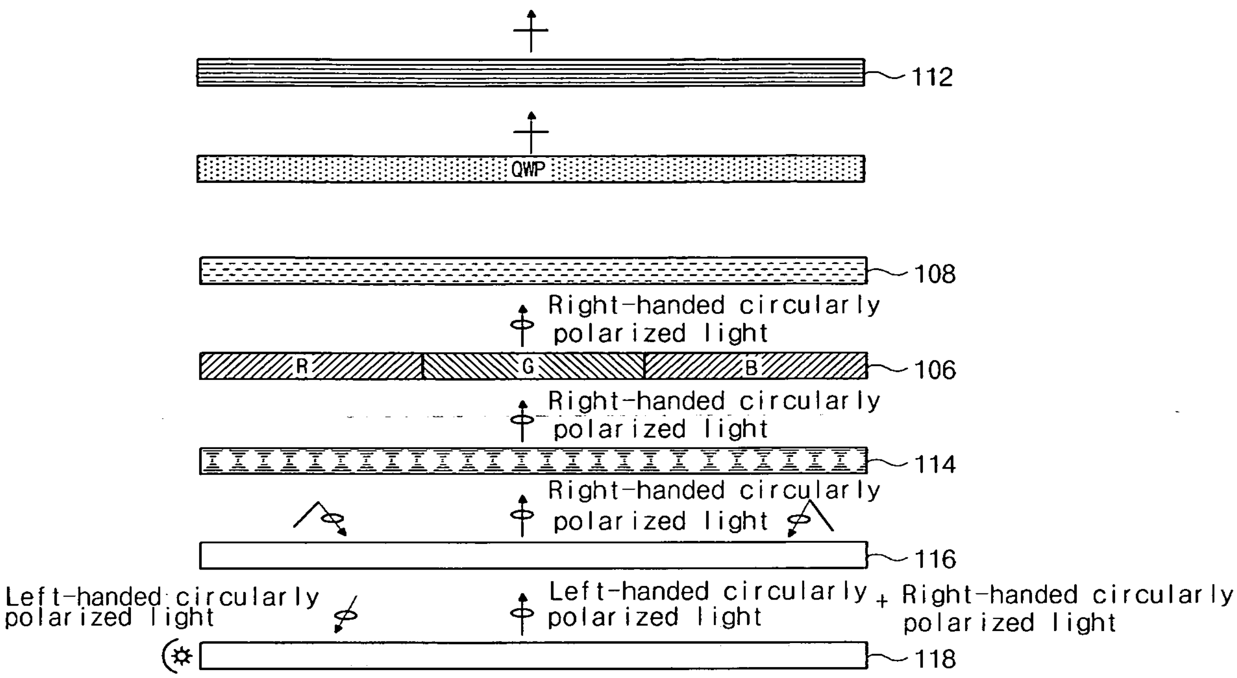
[FIG. 4]


linear polarizing plate
QWP
liquid crystal layer
R
G
B
100
112
110
102
108
106
104
114
116
118

[FIG. 5]

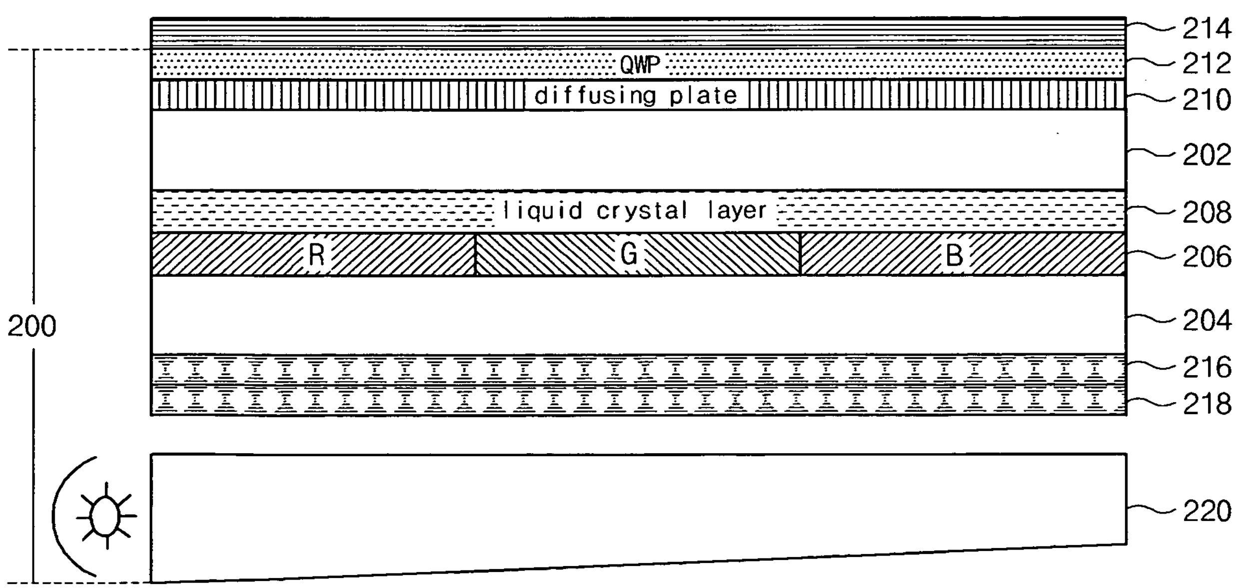

Right-handed circularly polarized light
114
right-handed helical pitch
Right-handed circularly polarized light
150
150
Right-handed circularly polarized light
Right-handed circularly polarized light
116
left-handed helical pitch
Left-handed circularly polarized light
Recycling
Right-handed circularly polarized light
+
Left-handed circularly polarized light
backlight
118
Reflectance
50
λB
λR
λR
Reflectance
100
50
Intensity
100%
380
λB
λG
λR
780

[FIG. 6]



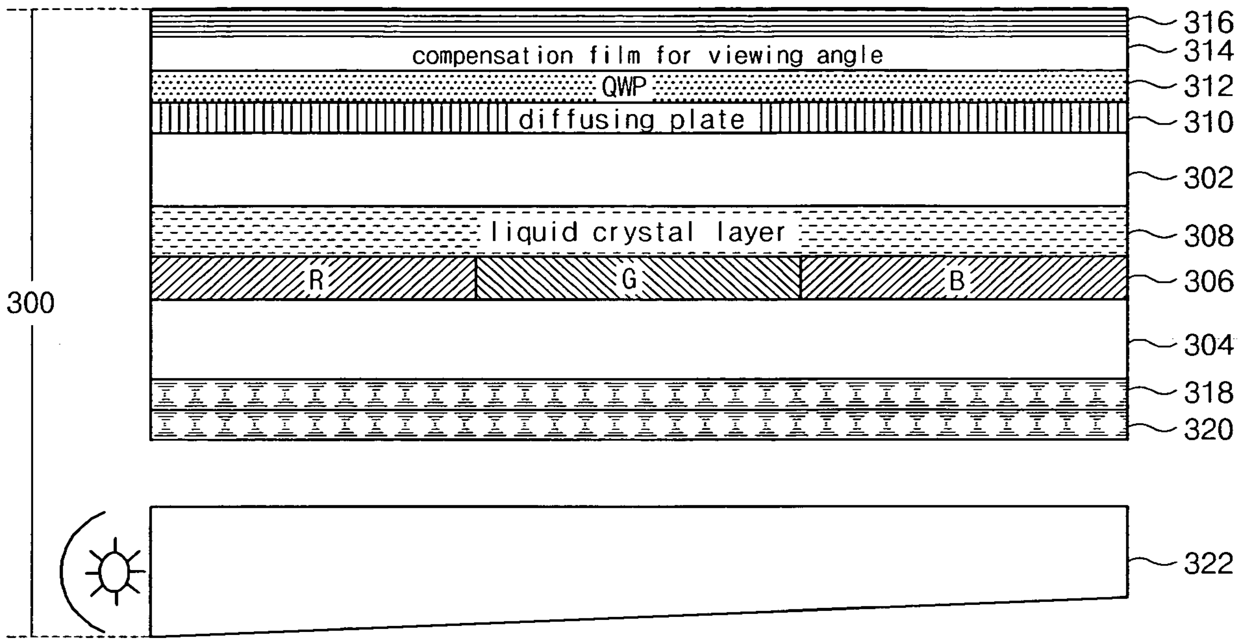
112
QWP
108
Right-handed circularly polarized light
R
G
B
106
Right-handed circularly polarized light
114
Right-handed circularly polarized light
116
Left-handed circularly polarized light
Left-handed circularly polarized light
+
Right-handed circularly polarized light
118

[FIG. 7]

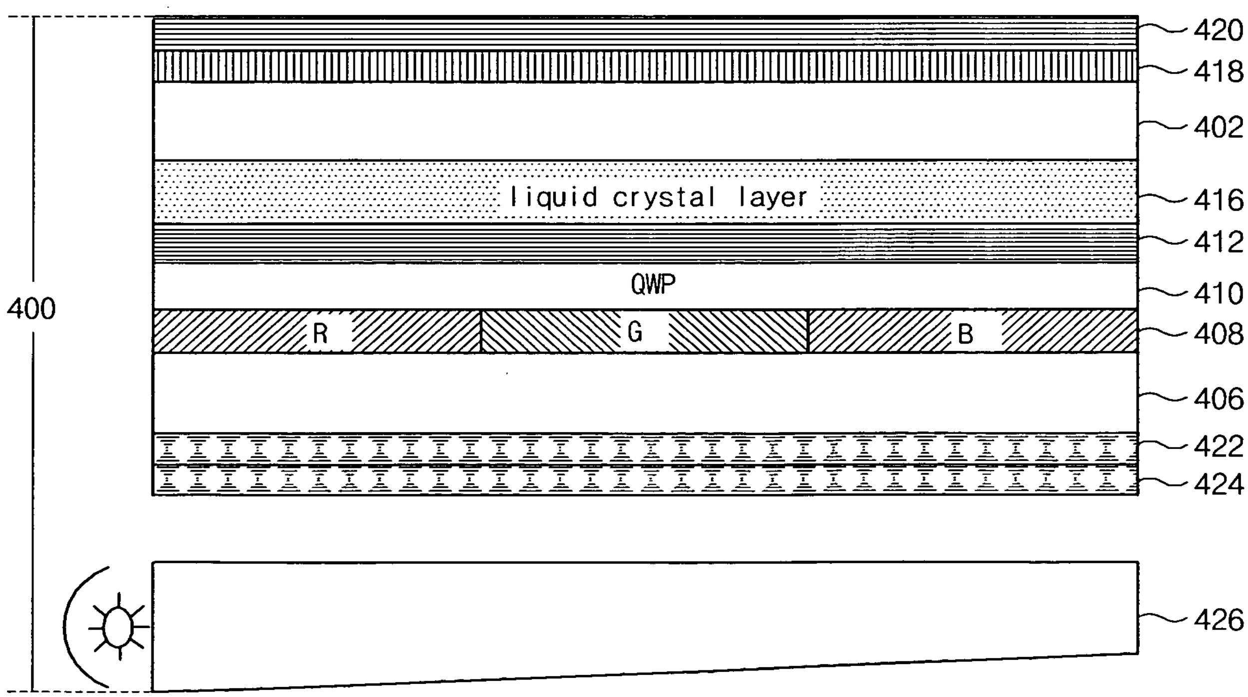


214
QWP
212
diffusing plate
210
202
liquid crystal layer
208
R
G
B
206
200
204
216
218
220

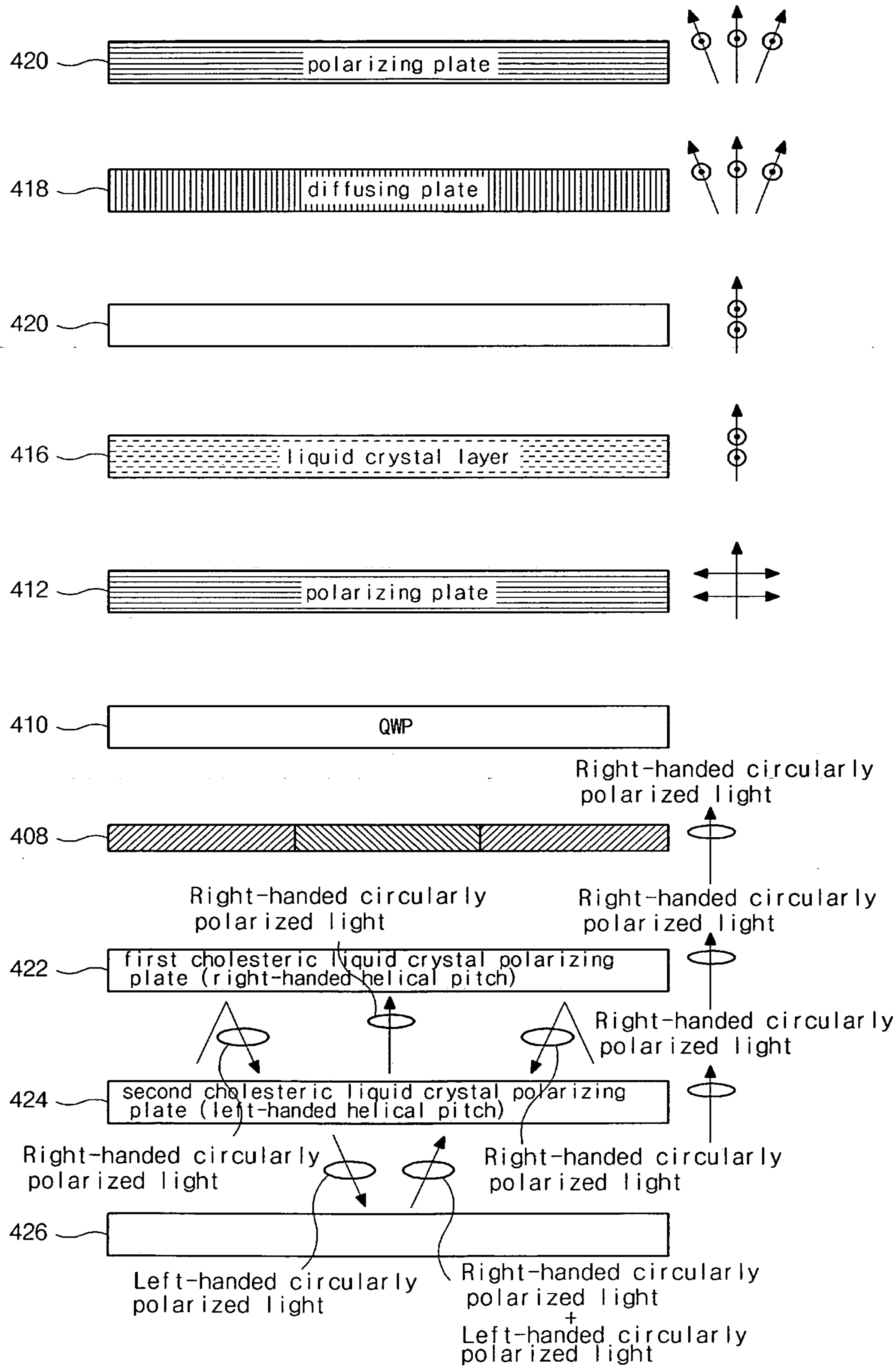
[FIG. 8]


316
compensation film for viewing angle
314
QWP
312
diffusing plate
310
302
liquid crystal layer
308
R
G
B
306
300
304
318
320
322

[FIG. 9]


420
418
402
liquid crystal layer
416
412
QWP
410
400
R
G
B
408
406
422
424
426

[FIG. 10]



420
polarizing plate
418
diffusing plate
420
416
liquid crystal layer
412
polarizing plate
410
QWP
Right-handed circularly polarized light
408
Right-handed circularly polarized light
Right-handed circularly polarized light
422
first cholesteric liquid crystal polarizing plate (right-handed helical pitch)
Right-handed circularly polarized light
424
second cholesteric liquid crystal polarizing plate (left-handed helical pitch)
Right-handed circularly polarized light
Right-handed circularly polarized light
426
Left-handed circularly polarized light
Right-handed circularly polarized light
+
Left-handed circularly polarized light